The Urinary 1-hydroxypyrene Biomarker in Street Janitors exposed to Air Quality Changes Associated with Religious events in Madinah, Saudi Arabia

Kordi KN[1], McNally RJ[1], Namdeo A[2]

Institute of Health & Society, Newcastle University

1- Institute of Health & Society, Newcastle University, Newcastle, UK
2- School of Engineering, Newcastle University, Newcastle, UK

Background

Madinah is the second most important Muslim holy city in Saudi Arabia. Particularly during holy months, traffic congestion and consequent air emission of several pollutant compounds, "mainly carcinogenic Benzo[a]pyrene (BaP)", is expected to reach high levels at certain locations. BaP is a potent carcinogen and mutagen found in diesel exhaust emissions[1]. It is classified by IARC as a human carcinogen (Group1) with a potential to bind to cellular proteins and DNA with toxic effects[2].1-Hydroxypyrene (1-OHP), a metabolite of pyrene, has been commonly used as urinary biomarker of (BaP) exposure[3].

Aim:

The aim of this study was to explore the levels of BaP in ambient air in Madinah at various locations to investigate the relationship between BaP and urinary 1-OHP among participants (street vendors).

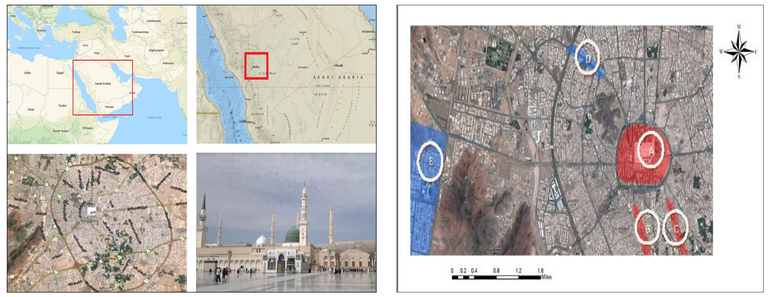


Figure 1: The Study Locations: (A) Downtown, (B) Quba, (C) Awali, (D) Sultana, (E) Al Aziziyah, in Madinah Saudi Arabia.

Methods

The research was designed as a time series study of one Islamic year to include three locations with high traffic density (Downtown, Quba, and Awali) and two control locations with low traffic activity (Sultana and Al-Aziziah) in Madinah (*Fig. 1)*. Twenty male street janitors participated in the study from the five locations. Daily breathing-zone BaP was measured using $PM_{2.5}$ personal samplers at the five locations. Morning and after-work urinary 1-OHP was measured daily. Daily traffic volumes were recorded at the same locations. Daily weather recordings were obtained at these locations. Statistical analysis was done using descriptive statistics, ANOVA, time series analysis and plots. Statistical significance was considered at $p< 0.05$ (*Figure 2)*.

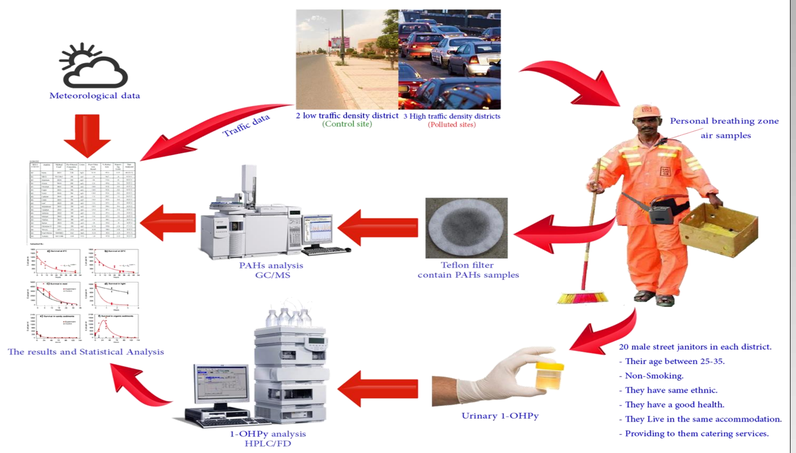
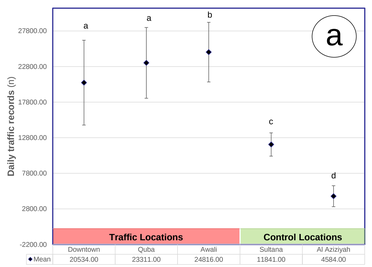


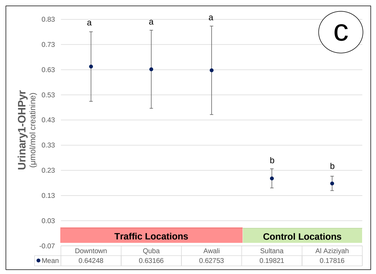
Figure 2: Flow chart of the study methodology

Results

Urinary 1-OHP, BaP and daily traffic volumes were significantly higher at the high traffic locations (Figure 3) compared to those in the control locations. Time series analysis using ARIMAX model for urinary 1-OHP showed that the only significant input variable was air BaP (Figure 4).

Figures 4 and 5 show that the time series were non-stationary as the means of BaP, 1-OHP concentrations and traffic records throughout the year were not constant. However, they were higher during the holy months (Ramadan- M9, Dhu al-Qadah11, Dhu al-Hijjah12 and Muḥarram1) at traffic locations.





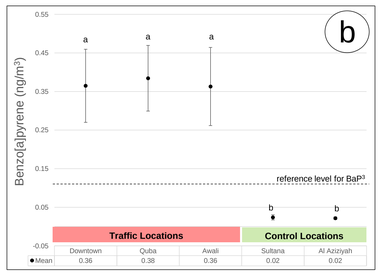


Figure 3: Means (±SD) of daily traffic records (a), personal air sampler benzo[a]pyrene (ng/m3)(b), and urinary 1-OHP (µmol/mol creatinine)(c), at five study locations in Madinah during Islamic calendar year from 1/4/1438 – 30/3/1439. Means with the different letter (a,b,c,d) are significantly different from each other according to post hoc (Tamhane's) test, p<0.05.

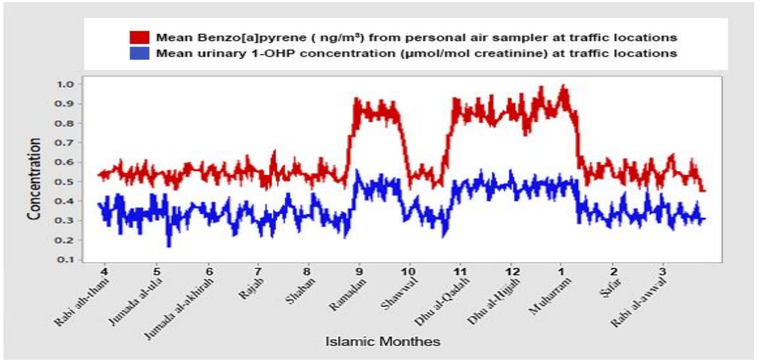


Figure 4: Time series graph of daily Benzo[a]pyrene (ng/m3) and urinary 1-OHP (µmol/mol creatinine) at traffic locations in Madinah for one Islamic calendar year from 1/4/1438 – 30/3/1439.

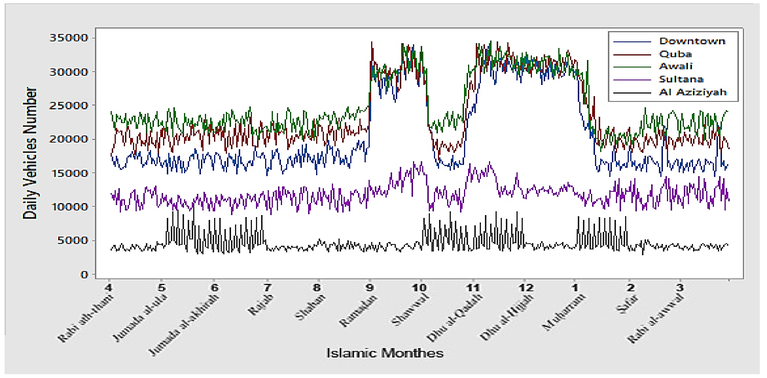


Figure 5: Time series graph of daily records of vehicles at five studied locations in Madinah for one Islamic calendar year from 1/4/1438 – 30/3/1439.

Conclusions

There is a noticeable rising rate of emitted BaP at traffic locations and holy months that is associated with elevated levels of urinary 1-OHP as a biomarker of exposure among the street janitors. It spotlights the importance of finding solutions to minimize its emission to protect the health of Madinah residents and visitors.

References

1. *WHO (2005) Health Effects of Transport-related Air Pollution. (Accessed: 05/03/2018).*
2. *IARC (2010) IARC monographs on the evaluation of carcinogenic risks to humans. In: Air Pollution, Part 1. Some Nonheterocyclic Polycyclic Aromatic Hydrocarbons and Some Related Industrial Exposures.*
3. *Mcclean, M. D., Osborn, L.(2012) 'Using urinary biomarkers of polycyclic aromatic compound exposure to guide exposure-reduction strategies among asphalt paving workers', Annals of occupational hygiene, 56(9), pp. 1013-1024.*